



Experiences in commercial microgrids

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Stone Edge Farm Microgrid Project



Wide variety of DERs

- ▶ Solar panels with soft-curtailment
- ▶ Batteries
9 different types have been tested
- ▶ Gas turbine with CHP
- ▶ Hydrogen system
Electrolyzer, H2 storage, fuel cells
- ▶ Controllable loads
Evs, motor/pumps, HVACs

Capabilities

- ▶ Grid-tie mode
Economic dispatch, Grid support
- ▶ Island Mode
Multi-master operation
- ▶ Transitions
Seamless islanding / reconnection
- ▶ Multi-energy system coordination
Electricity, heat, hydrogen, water



Behind the Meter



Location:

Colorado

Type: DER Site

Sector: Residential

Key Drivers:

Economic Optimization
Grid Services
Resilience



Location:

California

Type: Microgrid

Sector: Commercial

Key Drivers:

Resilience
Off-Grid Operations



Location:

Massachusetts

Type: DER Site

Sector: Industrial

Key Drivers:

Economic Optimization
Grid Services

Front of the Meter



Location:

Louisiana

Type: DER Site

Sector: Residential

Key Drivers:

Grid Services
T&D Deferral
Resilience



Location:

New Mexico

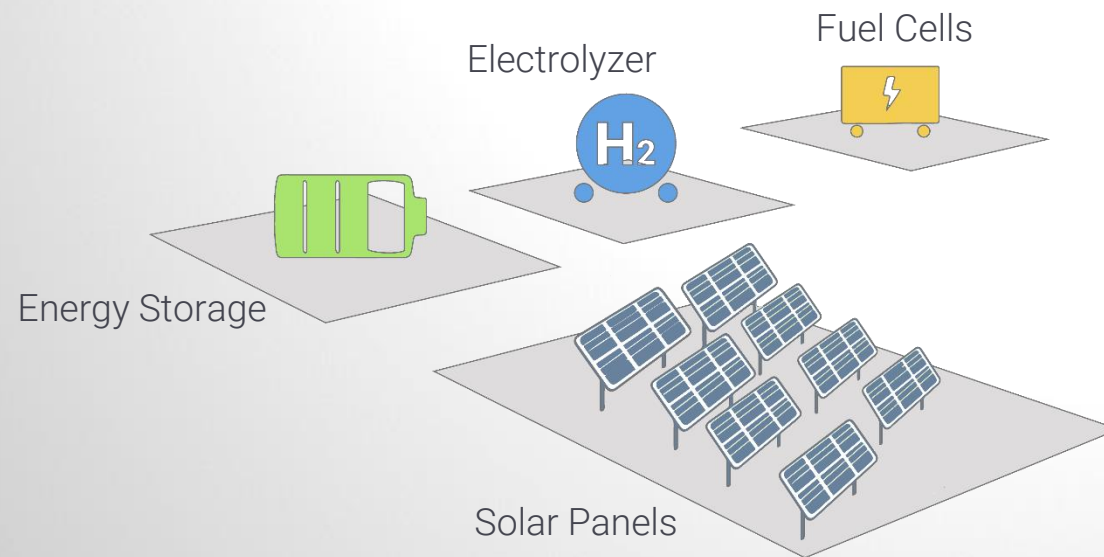
Type: Microgrid

Sector: Military

Key Drivers:

Economic Optimization
Grid Services
T&D Deferral
Resilience

A Microgrid is a collection of disparate energy resources that were **not designed to work together**



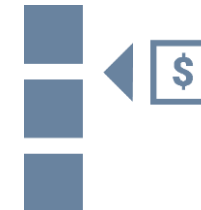
Main Challenges



Non-Standardized Ecosystem



Complex Systems



Rigid Structure

Non-Standardized Ecosystem



- Diversity
- Customization

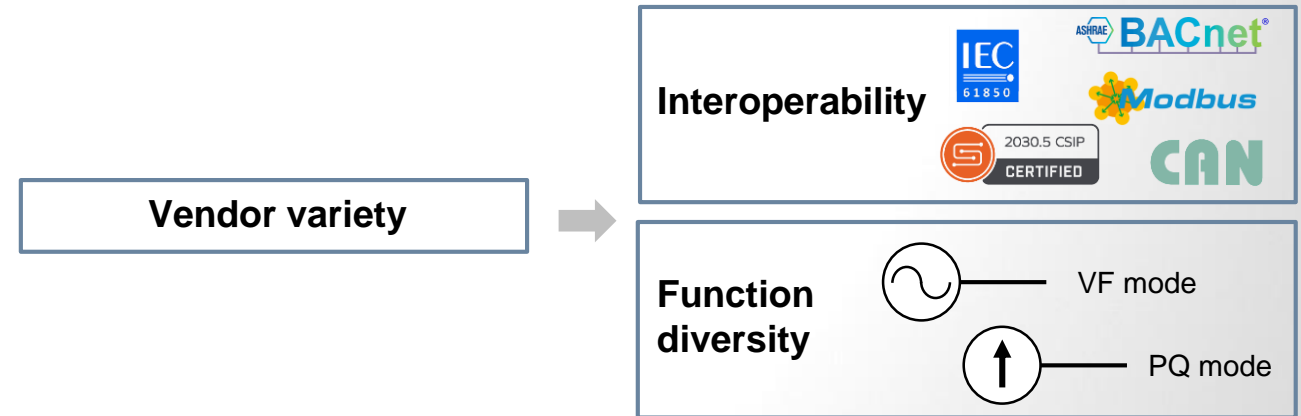


- Multiple objectives
- Multidisciplinary
- Uncertainties

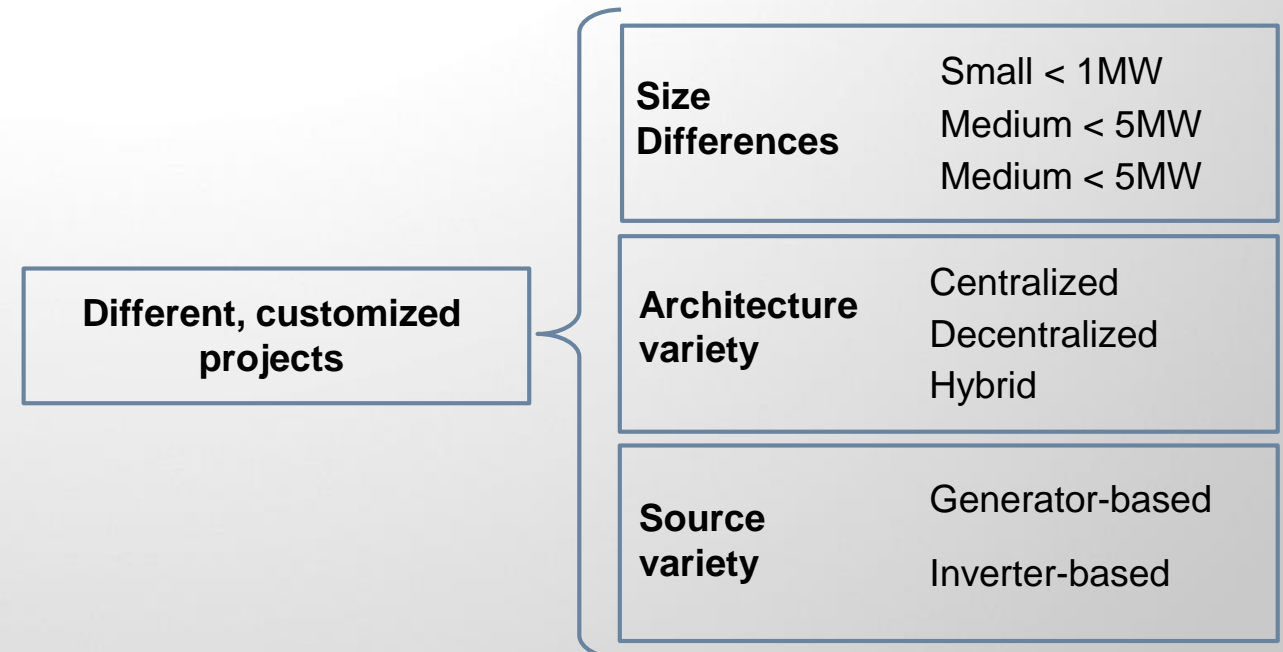


- Evolving System
- Continuous updates

Systems are constructed with a variety of technologies:



Microgrids are typically ones-offs:





- ▶ Diversity
- ▶ Customization

Complex Systems



- ▶ Multiple objectives
- ▶ Multi-energy
- ▶ Uncertainties



- ▶ Evolving System
- ▶ Continuous updates

Priority tradeoffs

Economic



Environmental



Resilience



Various energy types for loads and storage

Electricity



Heat



Hydrogen



Water



Uncertainties

Technical



Market





- ▶ Diversity
- ▶ Customization



- ▶ Multiple objectives
- ▶ Multidisciplinary
- ▶ Uncertainties

Rigid Structure



- ▶ Evolving Systems
- ▶ Continuous updates

Microgrids grow organically most often than not:

Evolving Needs

- Ex. Load increase:
- Electrified house
 - New EV
 - New production line



Evolving System

- Ex. System growth:
- Increased solar energy
 - More battery capacity

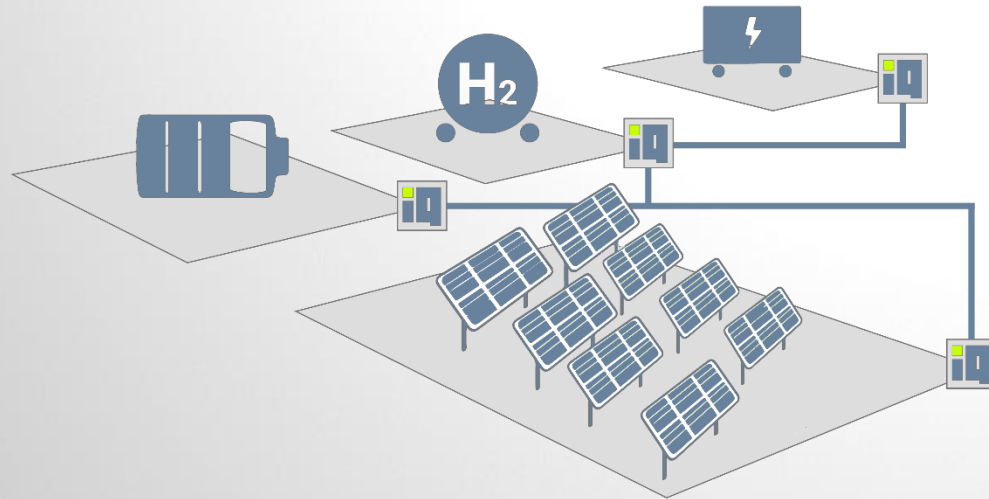
Software updates from vendors impact performance:



New firmware



HEILA aims to solve microgrids main challenges by creating **Microgrid “objects” or building blocks**



Solutions



Standardize
disparate energy
resources



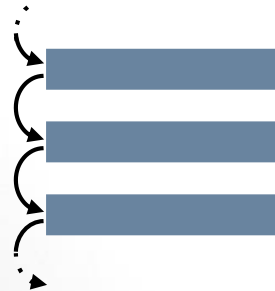
Encapsulate
complexity as
single entity



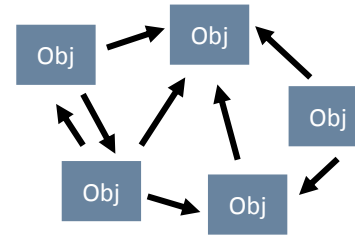
Simplify
scalability of
the system

An interesting **analogy** of the “Microgrid Object”:

Programming
paradigms



Procedural



Object-Oriented



Advantages

Separation of concerns

Modularity / reusability

Simpler Maintenance / Debugging

Information / Complexity hiding

Functions portability

Easier collaboration

Microgrid control
paradigms

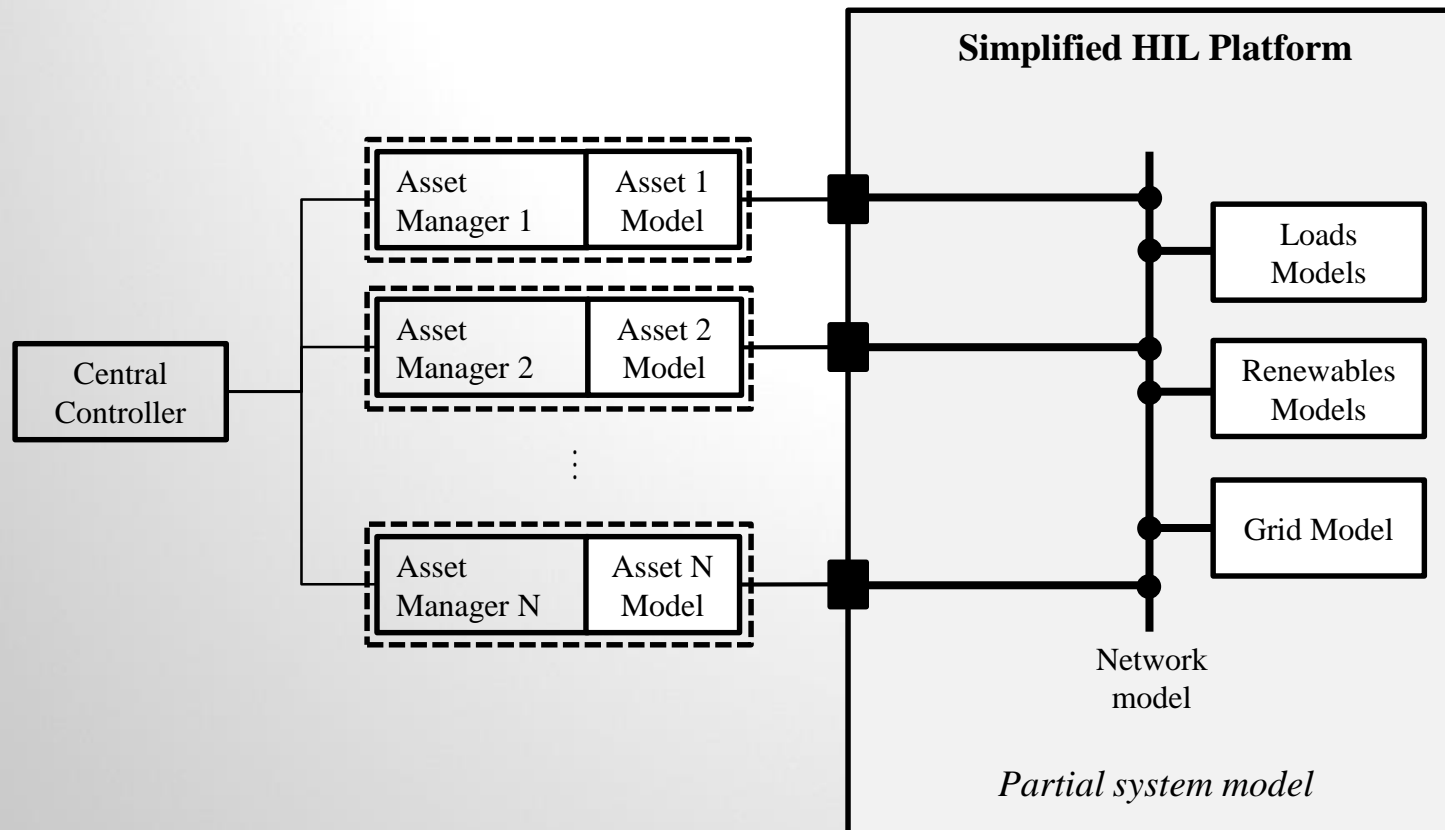


Centralized



Distributed / Decentralized

Co-simulations apply the same concepts, by solving the system in pieces:

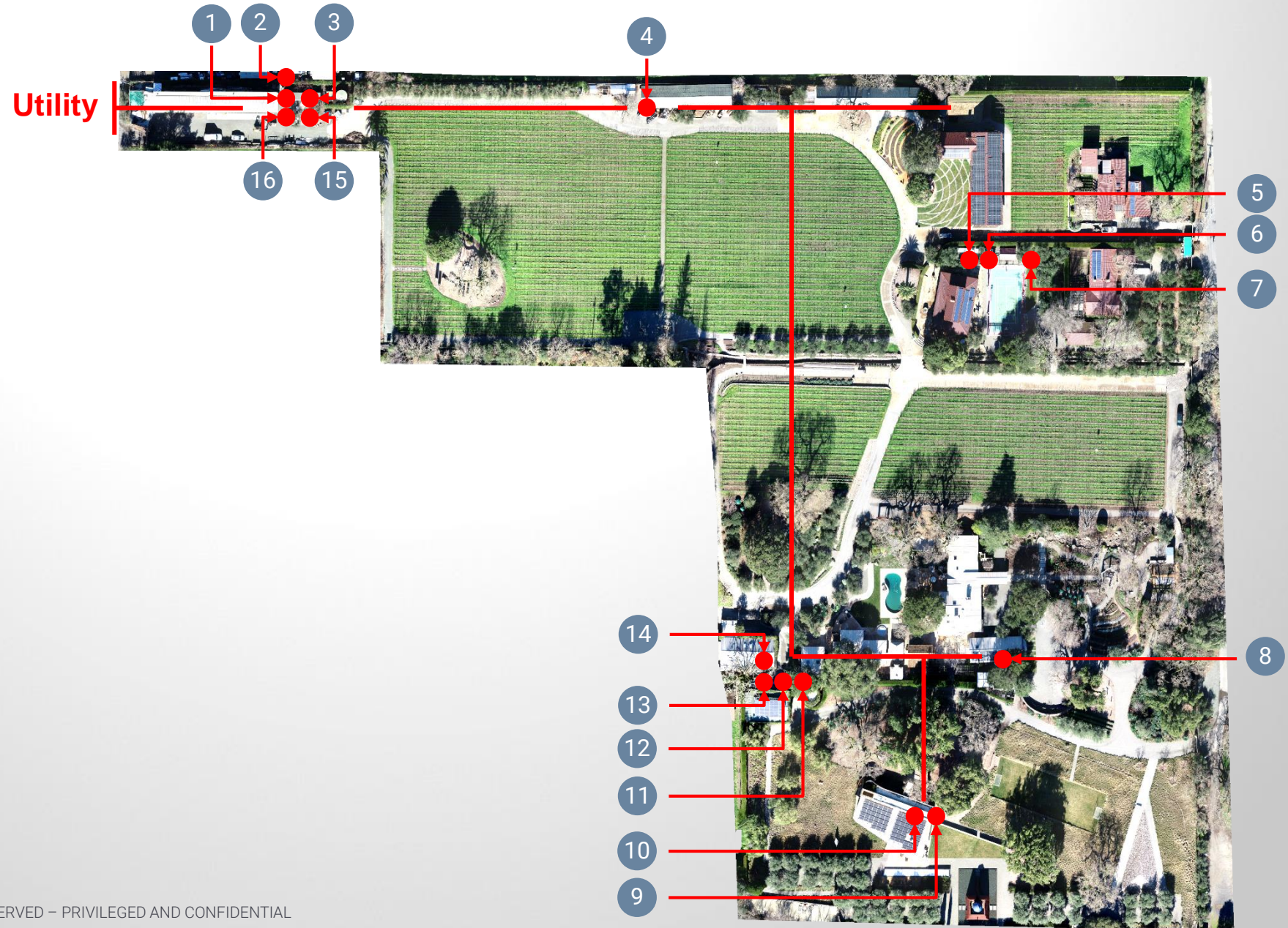


Advantages

- Separation of concerns**
- Modularity / reusability**
- Simpler Maintenance / Debugging**
- Information / Complexity hiding**
- Functions portability**
- Easier collaboration**

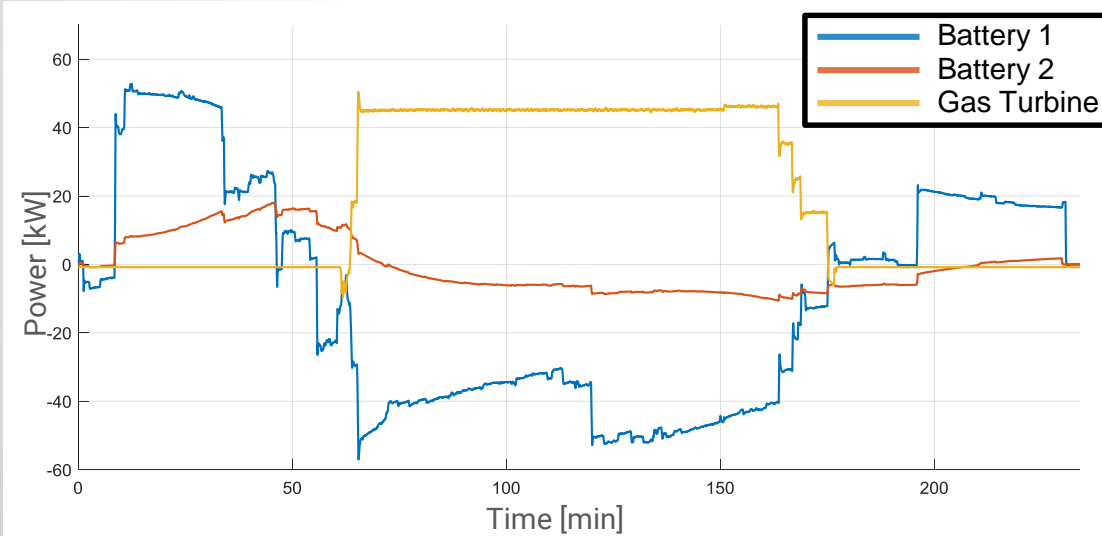
Use Case 1: Vendor agnostic

- 1 Giner Electrolyzer
- 2 Plug Power Fuel Cells
- 3 SimpliPhi + Dynapower
- 4 Sparkplug + Schneider
- 5 Tesla + Dynapower
- 6 SimpliPhi + Schneider
- 7 LG Chem + SolarEdge
- 8 Capstone gas turbine
- 9 SimpliPhi + SMA
- 10 Solar Fronius
- 11 Sony + Outback
- 12 Solar SMA
- 13 Hitachi VFD
- 14 Aquion + Ideal Power
- 15 Hitachi VFD
- 16 Outback FLEXpower

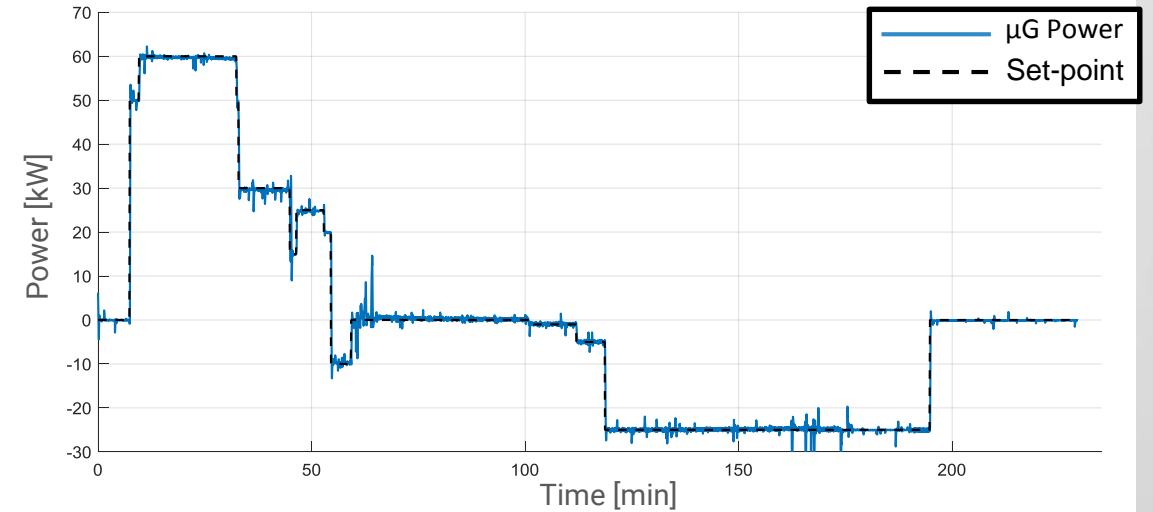


Use Case 1: Vendor agnostic

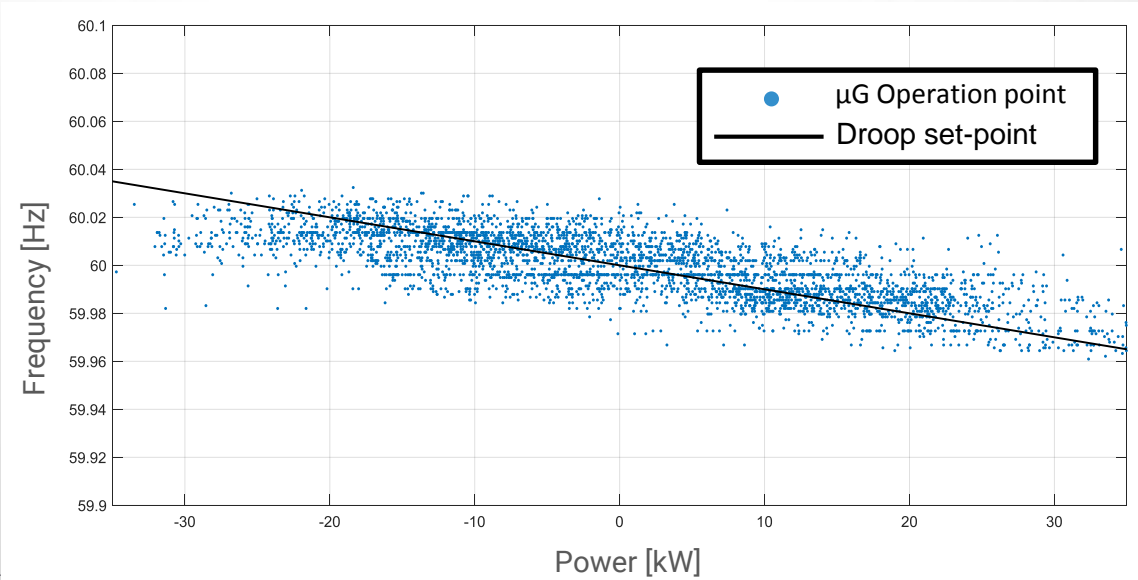
DERs make their own decisions...



...while still having the microgrid react as a single entity...



... and achieving objectives as a group

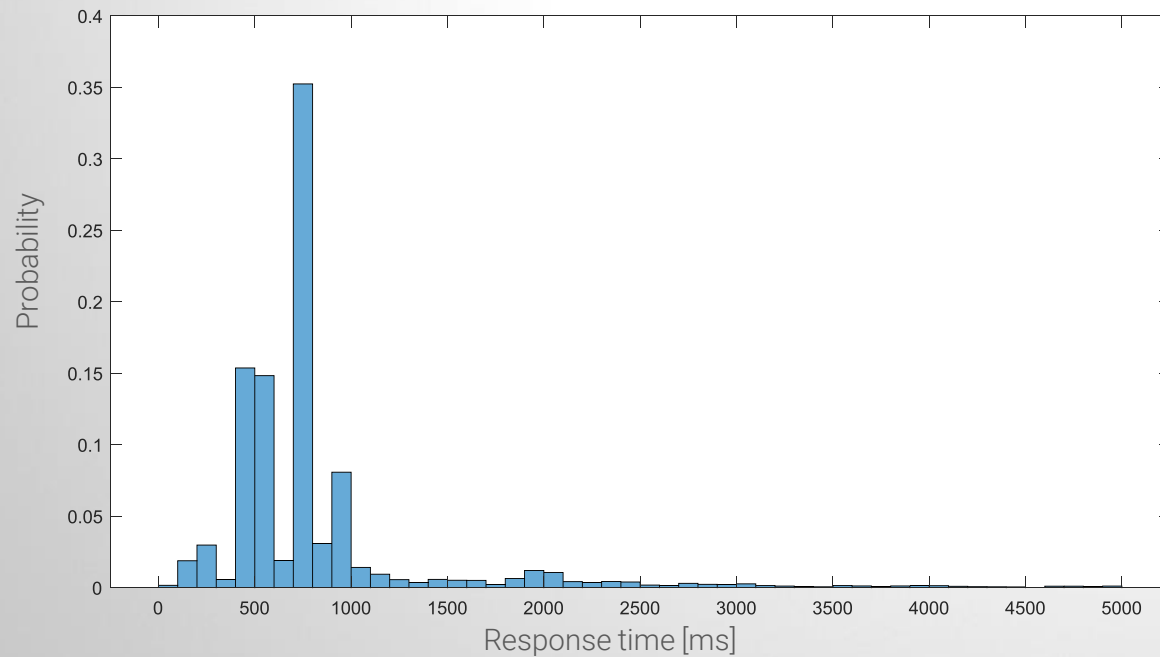


Use Case 1: Vendor agnostic

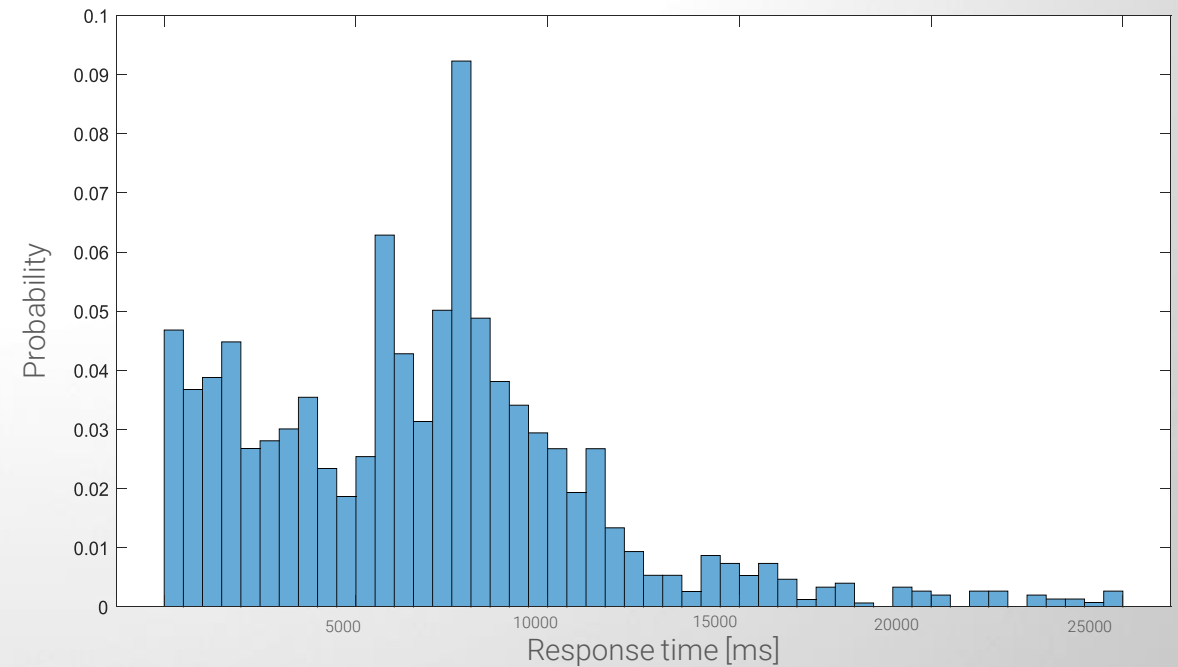
Use of data to tune control parameters

Example DER response time from set-point to stable output:

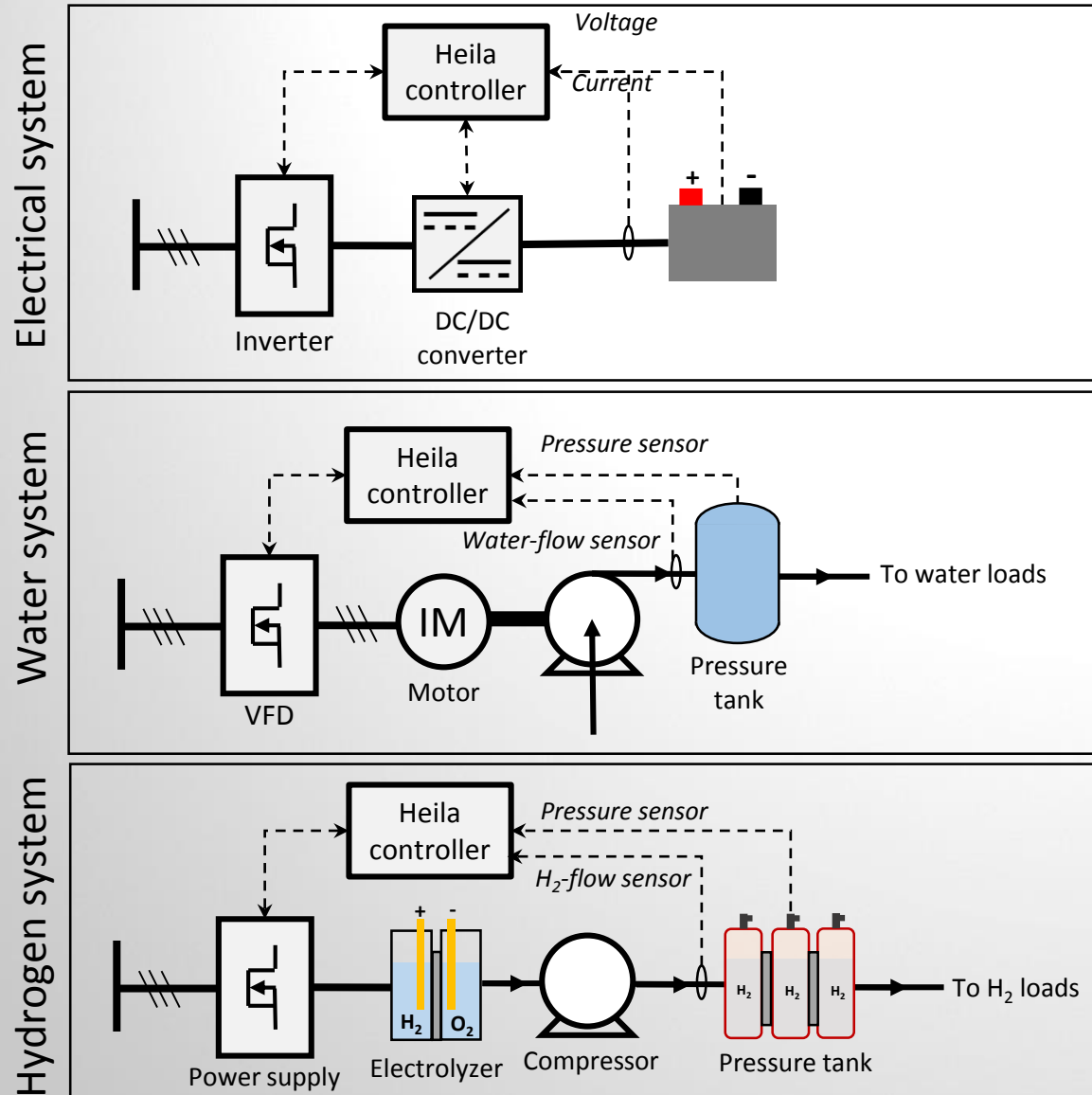
DER 1 – Response Time Histogram



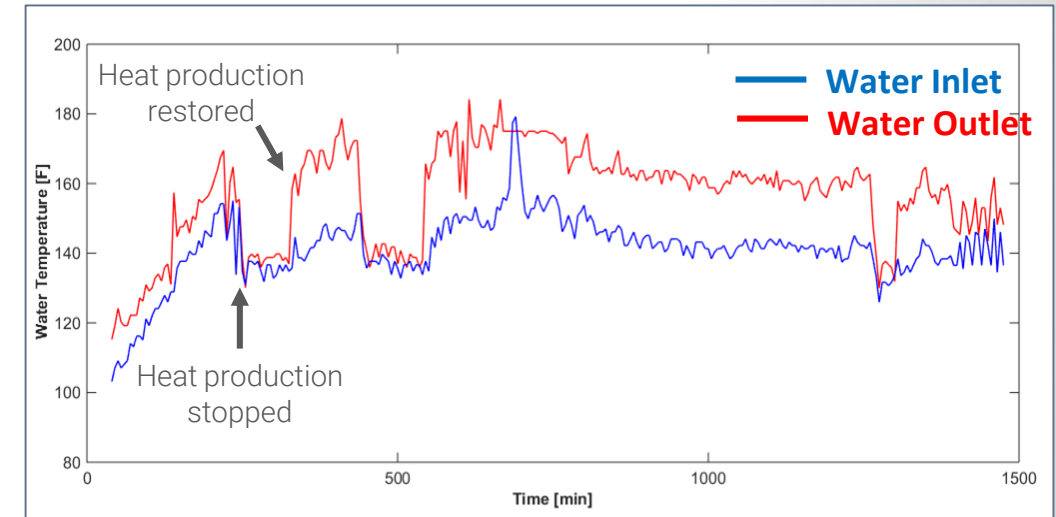
DER 2 – Response Time Histogram



Use Case 2: Energy Technology Agnostic



CHP System Control

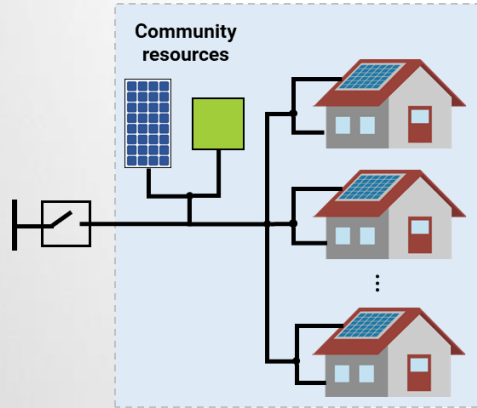


Hydrogen car re-fueling

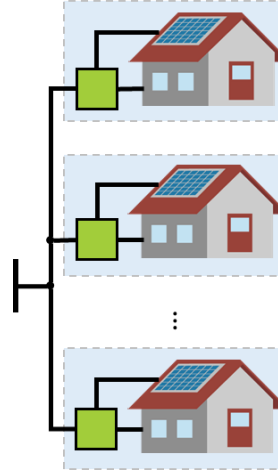


Use Case 3: Architecture Agnostic

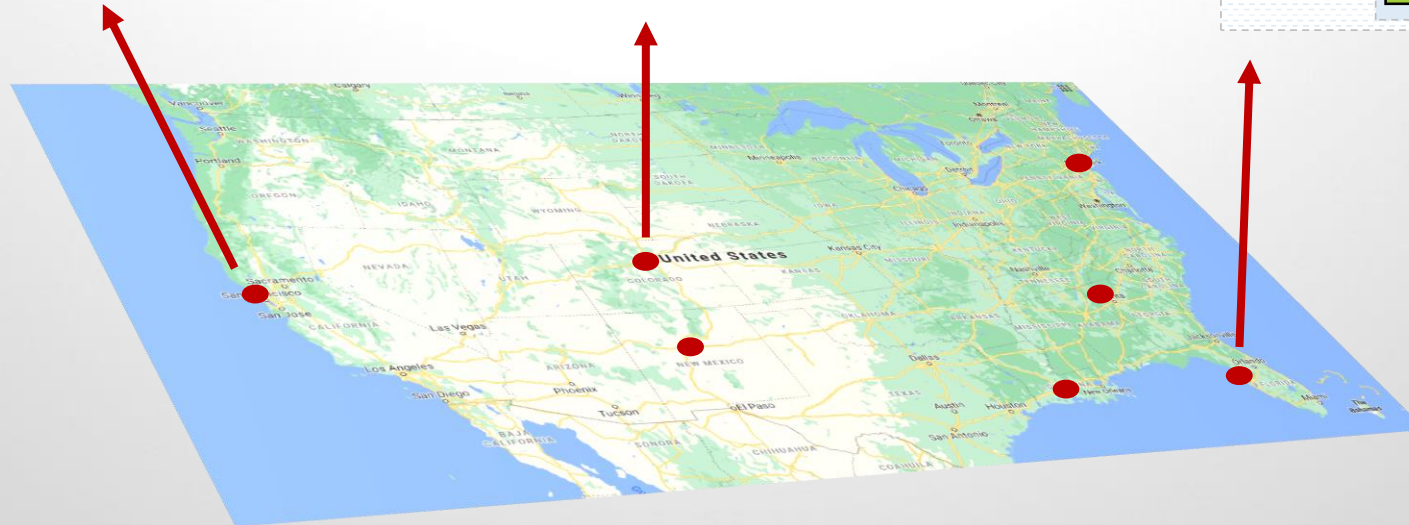
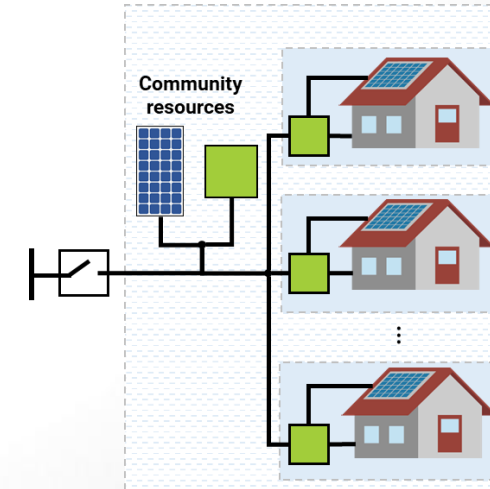
Centralized microgrids where resources are shared among all loads



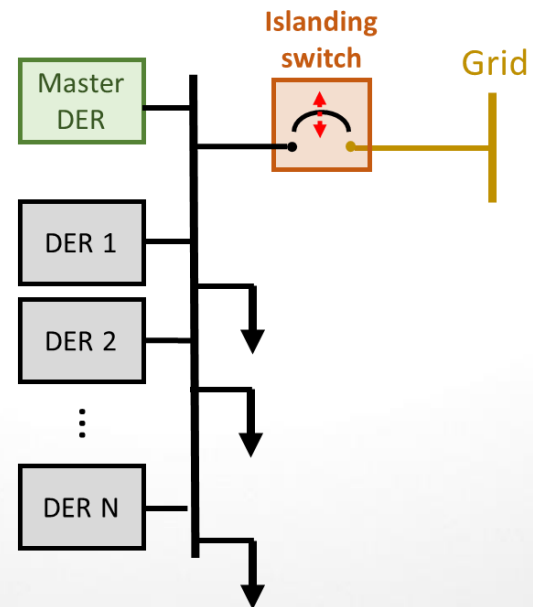
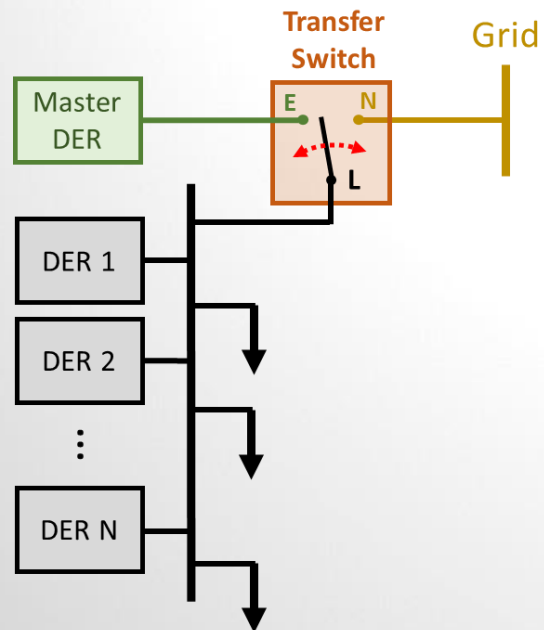
Distributed microgrids where each load has its own resources



Hybrid microgrids where some resources are shared and some are individual



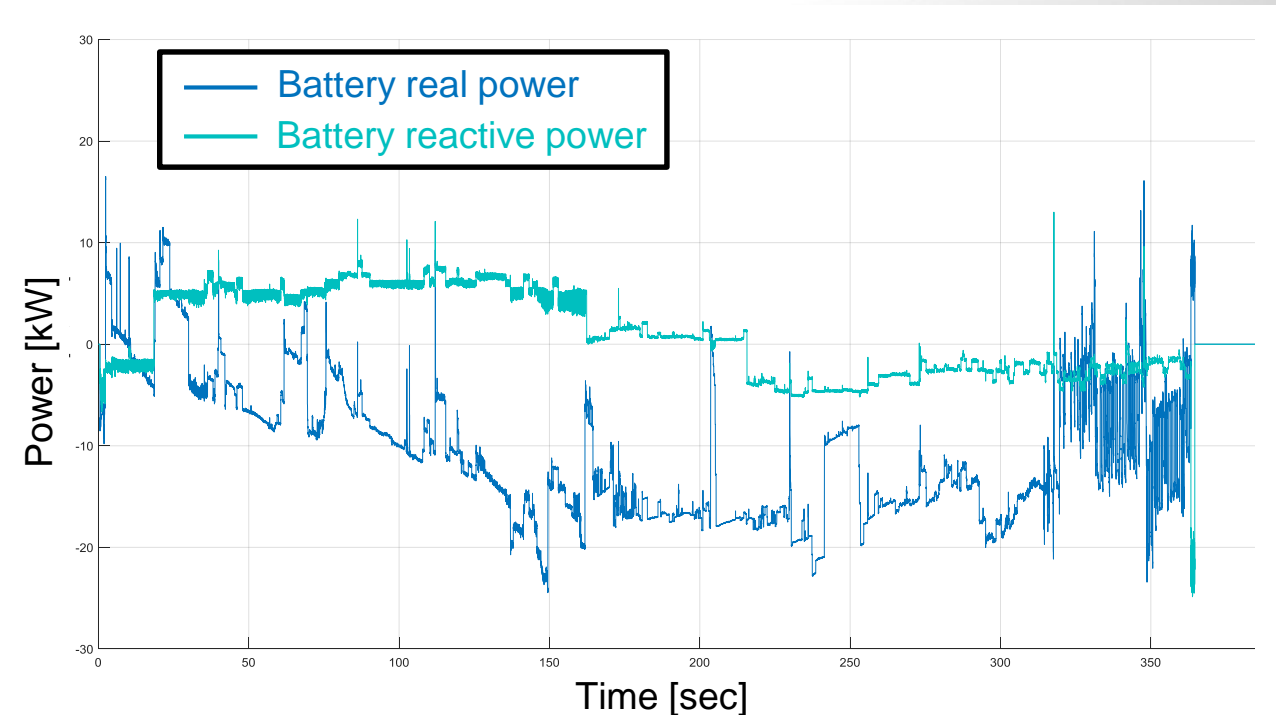
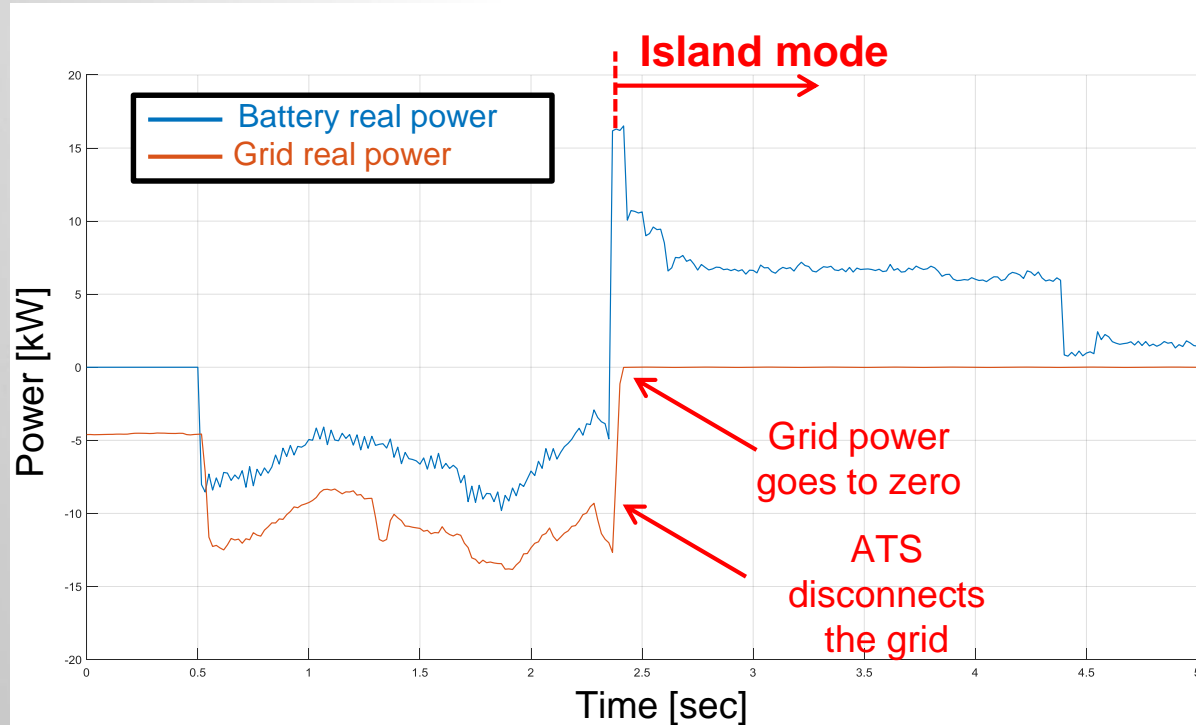
Use Case 4: Operation Mode Agnostic



Asco 7000

Use Case 4: Operation Mode Agnostic

Example of an islanding process and subsequent operation





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